A Tale of Two Index Futures: The Intraday Price Discovery Process between the China Financial Futures Exchange and the Singapore Exchange

Abstract

This is the first study to examine the intraday price discovery process between the Singapore Exchange and the China Financial Futures Exchange. Using one- and five-minute high-frequency data from May to November 2011, we found that China's CSI 300 index futures dominated Singapore's A50 index futures in terms of the price discovery process. However, A50 futures contracts also made a substantial contribution (26%-37%) to the price discovery process. A further division of the sample period into two sub-periods found that A50 futures dominated the price discovery process from May to August 2011 and that CSI 300 futures dominated the process from August to November 2011. These results have important implications for both traders and policymakers.

1. INTRODUCTION

On September 5, 2006, the Singapore Exchange issued SGX FTSE Xinhua China A50 index futures, which remain the only offshore futures on China's broad A-share markets. Three days later, the China Financial Futures Exchange (CFFEX) was established in Shanghai, which began the four-year-long preparation for China's own index futures. On September 18, 2006, the Shanghai Stock Exchange filed a lawsuit against FTSE XINHUA Co., claiming that its permission for the Singapore Exchange's use of data provided by the Shanghai Stock Exchange to compile the A50 index was illegal. In November 2006, the Shanghai court ruled in favor of the Shanghai Stock Exchange and fined FTSE XINHUA Co. USD 20,000. The latter appealed to the higher court but was rejected, ending the year-long legal battle. Witnessing the ever-decreasing trading volume of A50 futures, the Singapore Exchange reduced the contract size in November 2007 to increase the trading volume but saw it slide back to almost zero volume by the end of 2008. On April 16, 2010, the CFFEX finally introduced its long-awaited CSI 300 index futures after a four-year experiment based on mock trading between large qualified domestic institutions. In response, on August 23, 2010, the Singapore Exchange made substantial revisions to A50 futures contract specifications to increase its competitiveness. The contract size was reduced to USD 1 from USD 10 multiples of the futures price. Both T and T+1 sessions offered extended trading hours: The lunch break was cancelled for a continuous T session from 9 a.m. to 3:30 p.m., and the T+1 session traded from 4:10 p.m. to 1:00 a.m. the next day, which was later extended to 2 a.m. In addition, the initial margin was reduced from USD 1500 to USD 688. Table 1 shows the revisions made by the Singapore Exchange so far, which reflect a clear trend: extended trading hours and reduced entry barriers, contract sizes, and margin requirements.

This fierce competition between exchanges in China and Singapore for a dominant role in China's A-share index futures contracts has received considerable attention from global investors, media, and policymakers for several reasons. First, the Singapore Exchange introduced SGX Nikkei 225 Index Futures and SGX MSCI Taiwan Index Futures well before these two markets introduced their own futures contracts. Previous studies have shown that these offshore contracts have had considerable influence on the domestic markets (e.g., Roope & Zurbreugg, 2002; Covrig, Ding & Low, 2004; Chung & Hseu, 2008; Hsieh & Ma, 2008). Second, China is the latest market to introduce its own financial futures. Thus, its success has critical implications for the introduction of more advanced financial derivative products such as index and stock options. Many foreign institutions are interested in such potential investment opportunities in China's expanding financial markets. Third, in the short run, CSI 300 futures are likely to remain the only domestic financial product that investors can use to hedge against or speculate on China's broad A-share markets. The competition between CSI 200 futures and A50 futures may directly influence the investment decision and profitability of those investors who rely heavily on the direction of information flow. This issue has become particularly relevant because, since the last contract revisions by the Singapore Exchange, there have been dramatic increases in A50 futures trading volume and open interest.

In this regard, the present paper investigates the role of the Singapore Exchange in the competition for China's index futures markets. Specifically, the paper examines the pair wise price discovery processes between the CSI 300 index, newly introduced CFFEX CSI 300 index futures, SGX FTSE Xinhua China A50 index, and A50 index futures markets. Although the A50 futures market's trading volume is approximately one tenth that of the CSI 300 futures market and the A50 futures market has not impacted China's A-share markets as much as initially hoped, the Singapore Exchange does have several advantages in positioning the A50 index futures market as a major destination for foreign institutional investors who wish to hedge against or speculate on China's stock markets. First, the A50 index futures market has much lower entry barriers for investors. Its contract size is only one thirteenth that of CSI futures, and its initial margin is even lower. Second, the A50 futures market opens 15 minutes earlier and closes 10 minutes later than the CSI futures market. In addition, there is no lunch break in the A50 futures market. Third, the A50 futures market has an additional T+1 session that last until 2 a.m. the next day. When the market has unexpected news during extended T and T+1 sessions, the only place where investors can trade is the A50 futures market. Fourth, the A50 futures contract is settled in USD, which is particularly convenient for Western investors. Table 2 provides a comparison of A50 and CSI 300 index futures specifications. Thus, the A50 futures market now has the potential to compete with and possibly lead the CSI 300 futures market. The price discovery process between the two index futures represents an interesting and meaningful research question. However, although a number of studies have examined the price discovery process between SGX Nikkei 225 (SGX MSCI Taiwan) index futures and Nikkei 225 index futures (TAIFEX futures), few have addressed this process between A50 and CSI 300 index futures.

This study employs conventional methods in the price discovery literature, including the Granger causality test, the Hasbrouck information share, and the Gonzalo and Granger information share. Consistent with the findings of previous studies considering other markets, the present study's results indicate that each futures market dominated the corresponding spot market. The CSI (A50) futures market dominated the CSI (A50) spot market, representing a

76% (76%) information share at the one-minute frequency and a 61% (84%) information share at the five-minute frequency. Despite its relatively thin trading volume, A50 futures contributed 23%-26% at the one-minute frequency and 24%-36% at the five-minute frequency to price discovery process between the two futures markets, implying that after a year and a half, the CSI 300 futures market became mature and assumed its function as a leading marketplace for the price discovery process. We divided the sample period into two subperiods and found that A50 futures dominated CSI futures between May and August 2011 (the first half of the sample period), which is inconsistent with the common perception that the CSI futures market, with its much higher trading volume, is the leading place for trades based on new information. These results provide strong evidence that the Singapore Exchange does have an advantage in its competition with the CFFEX and suggests that the latter should maintain its efforts despite its recent achievements in the price discovery function.

The rest of this paper is organized as follows: Section 2 introduces the two index futures markets. Section 3 describes the data. Section 4 presents the empirical results using the full-sample data. A further analysis breaking the sample into two sub-periods is reported in Section 5. Section 6 concludes.

2. CSI 300 INDEX FUTURES AND A50 INDEX FUTURES

CSI 300 index futures are traded on the CFFEX, and its underlying asset is the CSI 300 index, which is composed with the 300 largest A-shares listed on the Shanghai Stock Exchange (179 stocks) and the Shenzhen Stock Exchange (121 stocks) by China Securities Index Co., Ltd. The trading volume of CSI 300 index futures increased sharply from 5,487,908 to 7,536,922 contracts in the first three months of trading, and the total turnover was over RMB 6,000 billion as of 2010. Figure 1 shows the daily trading volume from the first day of trading to November 21, 2011. There was a small decrease in average trading volume after August 23, 2010, when the Singapore Exchange revised its A50 futures contract specifications, but it increased since the latter half of 2011.

[Insert Figure 1 about here.]

The CSI 300 index futures market is completely order-driven. There is no market maker, and trading is conducted using a central computer system that matches buy and sell orders. Regular trading hours are from 09:15 to 11:30 and from 13:00 to 15:15, which means that it opens 15 minutes earlier and closes 15 minutes later than the spot market. However, for the purpose of price convergence, on each settlement day, the futures market closes at the same time as the spot market (15:00). Five types of futures contracts are traded simultaneously. Their expiration dates fall over the next three consecutive months and the two nearest quarter-end months (i.e., March, June, September, and December). The third Friday of each month is the settlement day, and the settlement price is calculated as the arithmetic average of the spot CSI 300 index during the last two trading hours of that day. The contract multiplier for each point is set as RMB 300. Regulators set RMB 500,000 as the minimum amount for opening a futures trading account, and the initial margin for each futures contract is 12% of its total value, that is, 12%*300*current futures price. The strict entry condition and the high-margin requirement limit noise traders. Similar to the spot market, the futures market has a daily price limit of ±10% with respect to the settlement price of the last trading day. In addition, there is a "circuit breaker" set at ±6%. Specifically, when changes in the daily futures price exceed ±6% and last for more than a minute, the circuit breaker is activated, and in the following 10 minutes, the bid/ask quotes are restricted to a range between -6% and 6%. Any quotes beyond this range are automatically denied. After 10 minutes, the price limit is expanded to ±10%, and normal trading activities resume. The circuit breaker is designed as a cooling-off system for stabilizing the market in extremely volatile conditions.

Few studies have focused on the CSI 300 index futures market because it is relatively new. Yang, Yang, and Zhou (2011) examined the price discovery process between the CSI 300 index and CSI 300 index futures markets by using high-frequency data from April 16, 2010, to July 30, 2010, and found that during this early stage, the CSI 300 futures market lagged behind the spot market in information flow and that there was some bidirectional intraday volatility transmission between the two markets. However, these findings are not consistent with the results of the present study, which considers a longer and more recent sample period.

SGX FTSE Xinhua A50 index futures are written on the SGX FTSE Xinhua A50 index, which is a tradable index composed of the largest 50 A-share firms by full market capitalization. They are stocks listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange and account for approximately 45% of the total market capitalization of the A-share market. The index is strongly correlated with the CSI 300 index and A-share ETFs, and major investors (including foreign institutions such as QFIIs and hedge funds) employ A50 futures to hedge against, speculate on, or invest in China's A-share markets. Unlike in the pure order-driven CSI 300 futures market, there are market makers for A50 futures. In addition, there are substantial differences in contract specifications between the two futures contracts. The contract months for A50 futures are the two nearest serial months and March, June, September, and December on a one-year cycle. The last trading day is the second-last business day of the contract month. Unlike in the case of CSI 300 futures, the final settlement price is the official closing price of the A50 index rounded to the nearest two decimal places. Compared with 10% price limits for CSI 300 futures, those for A50 futures are set to be 10% and 15% from the previous day's settlement price. When each limit is reached, there is a 10-minute cooling-off period, after which no price limits are set for the rest of the day. As shown in Figure 1, one striking phenomenon is that the trading volume, which was extremely low before the contract revisions in August 2010, increased sharply since then. This study is motivated by this observation.

3. DATA DESCRIPTION

We considered a sample period from May 9, 2011, to November 21, 2011, when the CSI 300 index futures market was in operation for more than a year and it had been nine months since the Singapore Exchange revised its A50 futures contract specifications. In addition, both markets were mature enough for an analysis of the price discovery process. Over the sample period, the CSI 300 spot index decreased from 3,164 to around 2,500 (Figure 2).

[Insert Figure 2 about here.]

We obtained one-minute data on the CSI 300 index, CSI 300 index futures, the A50 index, and A50 index futures from Bloomberg via Nanhua Futures Co., a leading futures brokerage and research institute in China. We employed the mid-quote price in the bid-ask spread to construct the price series. Because the four markets had different trading hours, we considered the common trading hours from 9:35 a.m. to 11:25 a.m. and from 1:05 p.m. to 2:55 p.m. for each trading day. We excluded the first and last five minutes in each trading session to avoid noise trades during opening and closing hours.[1] To construct a continuous series of futures contracts, we selected only the most active futures contracts, that is, we considered the contracts with the nearest maturity dates but excluded those with less than one week to maturity to avoid expiration day effects. A50 futures are traded in USD, whereas CSI 300 futures, in RMB. Thus, A50 futures prices should ideally be adjusted by the RMB/USD exchange rate. However, there was little change in this exchange rate over the sample period because of China's policy of managed floating rates: The average daily change in the exchange rate was -0.01% (S.D. =0.11%). For this reason, we analyzed only unadjusted A50 futures prices.[2] In addition, we normalized the four series by setting the first-day price/the index value in each series to be 1,000. As a result, we obtained a total of 29,541 data points for each series.

To examine how the price discovery process evolved over time intervals, we constructed a five-minute price series for each market. Following Roope and Zurbreugg (2002), we took the average of the two closest prices on both sides of the five-minute breaker to remove the potential downward bias from the use of the price closest to the five-minute breaker. We conducted all the tests for both one-minute and five-minute series.

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[1] We included the last five minutes in the morning session and the first five minutes in the afternoon session but found no qualitative differences in results.

[2] Ideally, we should have used the one-minute exchange rate for the adjustment, but we could obtain no intraday data. However, we expected no substantial impact on the results because we conducted the analysis based on the log return of the price series, not on the price itself. That is, taking the log of the price removes most the variations in the exchange rate, which should not be large for a managed floating rate. We conducted an additional analysis and verified that the use of the daily FX-adjusted price series had no influence on the results.

To examine the four markets' comovement, we took the log of one-minute (five-minute) returns for all series and computed their correlations (Table 3).[3] As shown in Panel A, for the one-minute interval, CSI spot and futures returns showed little synchronization, that is, there was a low correlation (0.35) between the returns. This may be because in practice it typically takes a hedger more than one minute to execute a buy/sell order for all 300 stocks in the index. In comparison, A50 spot and futures returns showed some co-movement (correlation=0.67), possibly because only about 15 seconds are needed to execute an order for A50 component stocks. This difference reflects the advantage of the Singapore futures market over the Chinese futures market in terms of the adjustment speed and hedging efficiency relative to each spot market. The two futures markets had the highest correlation (0.73), and the correlation between the two spot markets was 0.63, indicating some information flow between Singapore and China. Panel B shows the correlations for the five-minute return series. For longer time intervals, more information was incorporated into prices, and thus, there were substantial increases in all the correlations. For example, the correlation between CSI spot and futures returns increased sharply to 0.75, and that between the two spot (futures) markets increased to 0.91 (0.89).

[Insert Table 3 about here.]

Table 4 shows the descriptive statistics for each series. The results of the ADF test indicate that all price series fail to reject the null hypothesis of a unit root but that the return series justified the assumption of stationarity. As discussed in the next section, checking for stationarity was crucial for price discovery computations. The two futures series were less skewed and heavy-tailed than their spot series at the one-minute frequency but had approximately the same high moments at the five-minute frequency. In addition, for all series, five-minute returns had much less excess kurtosis than one-minute returns because of the smoothing effect.

[Insert Table 4 about here.]

[3] We excluded the first log return to avoid the bias associated with overnight returns.

4. METHODS AND EMPIRICAL RESULTS

We employed three well-known techniques to examine the price discovery processes between the four markets. To apply these methods, we first checked whether the four price series shared a common long-run stochastic trend. Intuitively, the four markets should share a common driving force, that is, the Chinese A-share stock market. We conducted the standard Johansen (1991) trace test to determine the number of common long-run trends (Table 5).[4] Panels A and B of Table 5 show three cointegration vectors for the one-minute series at the 5% level of significance and for the five-minute series at the 10% level, indicating a single long-run equilibrium point for the four series. Based on these results, we investigated the price discovery processes between the two futures markets, between the two indices, and between each futures market and its underlying index.

[Insert Table 5 about here.]

For the first method, we conducted a pairwise block exogeneity test with lagged returns for the four series. Equation 1 shows an error correction model (ECM) for markets i and j:

$$\Delta p_{i,t} = \alpha\left(p_{i,t-1} - p_{j,t-1}\right) + \sum_{k=1}^{N}\left(\beta_{i,k}\Delta p_{i,t-k} + \beta_{j,k}\Delta p_{j,t-k}\right) + \gamma D_t + \varepsilon_t \, , \qquad (1)$$

where p denotes the price vector; α represents the adjustment speed for markets i and j; β_k is the autoregressive coefficient for lag k; N is the number of lags (N=15); and D_t is a trend term.[5] Equation 1 separates short-term effects from long-term ones, allowing for the determination of whether market j Granger-causes market i (via a joint test that all coefficients $\beta_{j,k}$ are significantly different from zero) and whether market j is adjusting toward market i through a test of the statistical significance of α.

Panel A of Table 6 indicates that there were bidirectional lead-lag relationships between Singapore and China at the one-minute frequency but that the A50 futures market did not

[4] Because of the deterministic decreasing trend during the sample period (Figure 2), we conducted the Johansen trace test by assuming a linear trend component. The results of a unit root test for the four detrended series verify that all the detrended series were I (1) processes. We selected the optimal 15 lags for the Johansen trace test by using the Akaike information criterion (AIC) and employed the same lag structure for the rest of empirical analyses.

[5] All the tests assumed the existence of a linear trend component.

have a significant effect on the movement of the CSI 300 futures market at the 10% level. For each spot-futures pair, the futures market was more likely to influence its spot index than the other way round, as indicated by the F-statistic. For example, the F-value for the test that CSI 300 (A50) futures did not Granger-cause CSI 300 (A50) spot index was 969.59 (85.46), whereas that for the test that CSI 300 spot index did not Granger-cause CSI 300 futures was 2.42 (44.27). A50 spot was much more likely to Granger-cause CSI 300 spot price than the other way round, suggesting that in the spot market, A50 investors react to new market information faster than CSI 300 investors because the A50 index includes the largest 50 A-share firms. The results for the adjustment speed reveal three important points. First, the speed coefficient for the futures market was lower than that for the spot market for both Singapore and China, indicating that the spot market was more likely to adjust toward the futures market than the other way round. Second, the speed coefficient for the A50 futures market was much higher than that for the CSI 300 futures market, indicating that the A50 futures market tended to adjust toward the CSI 300 futures market. Third, the coefficients for both the A50 and CSI 300 spot markets were significant at the 10% level, although the coefficient for the A50 was higher, indicating the mutual adjustment of these two markets. This result is not surprising because these two markets, roughly speaking, represent the same Chinese market. The results for the coarser five-minute level (Panel B) indicate similar observations. However, the effects of the two spot markets on their respective futures markets were weaker and insignificant, indicating that the spot markets led the futures markets only temporarily.

[Insert Table 6 about here.]

For the second method, we employed Hasbrouck's (1995) information share, which measures the contribution of a particular market to the total variation in common trend innovations that drive two markets. Table 7 shows the mean and upper/lower bounds of information shares for each pair of the four markets. The results indicate that CSI futures contributed more to the price discovery process than A50 futures. However, A50 futures also made substantial contributions (26%-37%) to the total variation in price common trend innovations. This finding, although being reasonable due to the relatively small size of the trading volume for

A50 futures, is revealing because previously investors and Exchange policy makers have expected a much smaller role played by the A50 futures in the price discovery process between the two markets. Between the two spot markets the A50 spot market contributed approximately 40% to the price discovery process. This is consistent with the result of the Granger causality test in Table 6, which indicated the mutual influence of the spot markets. In addition, the results confirm that both CSI futures and A50 futures dominated their respective spot markets. Yang, Yang, and Zhou (2011) reported that CSI futures did not play a leading role in the price discovery process for the first three and a half months, possibly because of high entry barriers. The present study's results indicate that in about one year after its introduction, the CSI futures market has established its price discovery function and dominated the spot market in information flow. At the five-minute frequency, results are qualitatively similar, but with most dominance diminished except for the CSI spot market versus the A50 spot market. In general, the Chinese market functioned well in terms of its dominant contributions to the price discovery process between the markets, indicating that more investors traded in the Chinese market once they had new information on China's A-share firms. On the other hand, the Singapore Exchange did account for some portion of price discovery and warrants attention from Chinese Exchange policy makers.

[Insert Table 7 about here.]

For the final method, we employed the Gonzalo-Granger information share (Table 8). The results indicate similar patterns for one- and five-minute series. For instance, for the one-minute series, the CSI 300 futures market clearly dominated the A50 futures market (77% vs. 23%); each futures market led its spot market (76% vs. 24% for China and Singapore, respectively); and the CSI 300 spot market led the A50 spot market (77% vs. 23%). There are at least two possible reasons why the CSI 300 market dominated the A50 market. First, the CSI futures market and its influence grew rapidly, and thus, investors tended to enter this market when they had new information. Second, the authors' conversation with futures traders suggests that many institutional investors employ algorithmic trading for CSI 300 futures because of their large trading volume but that this is not the case for A50 futures.

[Insert Table 8 about here.]

5. SUBSAMPLE ANALYSIS

Motivated by the dramatic increase in the trading volume of A50 futures since August 2010, we divided the sample period into two sub-periods with roughly equal length and conducted analyses separately to better examine the time-varying role of each market. Table 9 shows the Hasbrouck information shares for the two subperiods. In the first subperiod, Singapore dominated China in terms of both spot and futures markets, whereas in the second subperiod, China dominated Singapore in terms of both markets. More specifically, the mean share for the CSI 300 (A50) futures market was 36% (64%) in the first subperiod, whereas it was 75% (25%) in the second subperiod. For the CSI 300 (A50) spot market, the mean share changed from 31% (69%) to 60% (40%). However, the two futures markets still led their respective spot markets. These results are consistent with the Gonzalo-Granger information shares in Table 10. This switch in their dominance may suggest that Singapore led China in the early stages of competition because of its markets were convenient and familiar to overseas investors. As the CSI futures market grew and became more mature, investors realized its increasing importance, and as a result, information started to flow from China's markets to Singapore's markets. A more possibly explanation, however, is that from May to August 2011, the international market was the major source of information for trading, e.g. the European Sovereign debt crisis, US treasury rating downgrading, global economic outlook, which induced investors to first consider the Singapore Exchange. Then market markers hedged their positions by using CSI futures contracts. From August to November 2011, however, investor's major focus was on domestic information in China, e.g. the Chinese inflation rate and macroeconomic control policy, the possibility of housing bubble burst, banking industry health. The attention on Chinese economy in the latter half of 2011 was highlighted when it was reported that large amount of hot money fled China. In any case, CFFEX policymakers should recognize that A50 futures are likely to remain a powerful competitor for some time.

[Insert Table 9 about here.]

[Insert Table 10 about here.]

6. CONCLUSIONS

This paper examines the intraday price discovery processes between the CSI 300 spot, A50 spot, CSI 300 index futures, and A50 index futures markets. The results indicate that on average the CSI 300 futures started to outperform A50 futures in terms of the price discovery process. Based on two well-known measures of the information share, CSI 300 futures led A50 futures and contributed more to the price discovery process. However, given that the A50 futures market was smaller than the CSI 300 futures market in absolute as well as relative terms, its 26%-37% information share was relatively large. Furthermore, the results of an additional analysis reveal that during the first sub-period (i.e., from May to August 2011), A50 futures played a dominant role in the price discovery process. These results suggest that Chinese policymakers should continue to pay close attention to A50 futures, particularly because (as shown in Figure 1) the trading volume of A50 futures grew faster than that of CSI 300 futures since August 23, 2010. As a strategy, the Chinese futures market can reduce its contract sizes and entry barriers to attract more retail investors and foreign investors. Taiwan's TAIFEX market played a minor role until it reduced its tax rate, which allowed its trading volume to surpass that of MSCI Taiwan index futures. In this regard, future research should examine which factors (e.g., trading volume, market makers, the T+1 session, and information origin) play the most important roles in the price discovery function of A50 futures. In any case, the competition between the Singapore Exchange and the CFFEX for the dominance of financial futures is far from over, and it is still premature to declare the winner.

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TABLE 1: COMPETITION FOR INDEX FUTURES CONTRACTS BETWEEN EXCHANGES IN CHINA AND SINGAPORE

	Before	August 23, 2010	After
Contract Size	USD 10 * SGX A50 Index Futures price	USD 1 * SGX A50 Index Futures price ≈ USD 8,500	USD 1 * SGX A50 Index Futures price ≈ USD 9,300
Trading Hours	9:15 a.m. ～ 11:35 a.m.; 1:00 p.m. ～ 3:05 p.m.; T+1: 3:40 p.m. ～ 10:55 p.m.	9:00 a.m. ～ 3:30 p.m.; T+1: 4:10 p.m. ～ 1:00 p.m. (the next day)	9:00 a.m. ～ 3:25 p.m.; T+1: 4:10 p.m. ～ 02:55 a.m. (the next day)
Margins	Initial margin: USD 1,500	Initial margin: USD 688; Maintenance: USD 550	Initial margin: USD 563; Maintenance: USD 450
Negotiated Large Trades	200 lots	50 lots	50 lots

TABLE 2: COMPARISON OF INDEX FUTURES CONTRACTS BETWEEN EXCHANGES IN CHINA AND SINGAPORE (As of 11/20/2011)

Exchange	CSI 300 Index Futures	SGX A50 Index Futures
Contract Size	CSI 300 Index Futures price * 300 ≈USD 122,646 ($/￥=6.36)	USD 1 * SGX A50 Index Futures price ≈ USD 9,300
Trading Hours	9:15 a.m. ～ 11:30 a.m.; 1:00 p.m. ～ 3:15 p.m.	9:00 a.m. ～ 3:25 p.m.; T+1: 4:10 p.m. ～ 2:00 p.m. (the next day)
Initial Margins	12%～15% of the contract value	6% of the contract value
Last Trading Day	Third Friday of each month	Second-last business day of the contract month
Settlement Price	Arithmetic average of index prices in the last two hours on the last trading day	Official closing price of the A50 index rounded to the nearest two decimal places

TABLE 3: CORRELATION MATRIX FOR INDEX AND INDEX FUTURES MARKETS (ONE- AND FIVE-MINUTE LOG RETURNS)

	CSI 300 Spot	CSI30 Futures	A50 Spot	A50 Futures
Panel A: Correlations for One-Minute Returns				
CSI 300 Spot	1.0000			
CSI 300 Futures	0.3506	1.0000		
A50 Spot	0.6323	0.6215	1.0000	
A50 Futures	0.4158	0.7346	0.6668	1.0000
Panel B: Correlations for Five-Minute Returns				
CSI 300 Spot	1.0000			
CSI 300 Futures	0.7535	1.0000		
A50 Spot	0.9170	0.8437	1.0000	
A50 Futures	0.7611	0.8913	0.8627	1.0000

TABLE 4: SUMMARY STATISTICS FOR INDEX AND INDEX FUTURES MARKETS (LOG PRICES AND RETURNS)

	CSI 300 Spot	CSI30 Futures	A50 Spot	A50 Futures
Panel A: Summary Statistics for One-Minute Returns				
ADF (log prices)	-2.2739	-2.2362	-2.4111	-2.4070
Prob (log prices)	0.4622	0.4783	0.4040	0.4057
ADF (returns)	-42.3113	-42.6009	-42.3690	-42.3761
Prob (returns)	0.0100	0.0100	0.0100	0.0100
Mean	-0.0003	-0.0005	-0.0002	-0.0004
Std. Dev.	0.0469	0.0662	0.0528	0.0662
Skewness	1.3837	0.5323	1.3801	0.6061
Excess Kurtosis	19.3851	12.1116	18.0320	7.8223
Panel B: Summary Statistics for Five-Minute Returns				
ADF (log prices)	-2.3472	-2.3450	-2.4567	-2.4566
Prob (log prices)	0.4313	0.4322	0.3849	0.3850
ADF (returns)	-22.6207	-22.0993	-22.9433	-22.5326
Prob (returns)	0.0100	0.0100	0.0100	0.0100
Mean	-0.0018	-0.0027	-0.0018	-0.0023
Std. Dev.	0.1507	0.1521	0.1430	0.1493
Skewness	0.6666	0.6315	0.8790	0.6194
Excess Kurtosis	5.0099	6.0364	5.1680	4.3111

TABLE 5: JOHANSEN TRACE TEST

	Trace	Prob (0.1)	Prob (0.05)	Prob (0.01)
Panel A: Trace Test for One-Minute Returns				
r <= 3	5.9190	10.4900	12.2500	16.2600
r <= 2	28.9316	22.7600	25.3200	30.4500
r <= 1	87.4962	39.0600	42.4400	48.4500
r = 0	241.9822	59.1400	62.9900	70.0500
Panel B: Trace Test for Five-Minute Returns				
r <= 3	6.7007	10.4900	12.2500	16.2600
r <= 2	24.4847	22.7600	25.3200	30.4500
r <= 1	61.0764	39.0600	42.4400	48.4500
r = 0	143.1154	59.1400	62.9900	70.0500

TABLE 6: PAIRWISE GRANGER CAUSALITY TEST

	Joint test	p-value	Speed of adjustment	p-value
Panel A: Causality Test for One-Minute Returns				
The CSI 300 future market did not Granger-cause the CSI 300 spot market	969.5890	0.0000	-6.9837E-03	0.0000
The CSI 300 spot market did not Granger-cause the CSI 300 futures market	2.4201	0.0016	-4.3591E-03	0.0296
The A50 futures market did not Granger-cause the A50 spot market	85.4647	0.0000	-2.8207E-03	0.0056
The A50 spot market did not Granger-cause the A50 futures market	44.2777	0.0000	-2.3296E-03	0.0757
The CSI 300 futures market did not Granger-cause the A50 futures market	158.8433	0.0000	3.8362E-04	0.1691
The A50 futures market did not Granger-cause the CSI 300 futures market	1.3226	0.1783	-7.5102E-04	0.0097
The CSI 300 spot market did not Granger-cause the A50 spot market	8.8562	0.0000	4.1736E-04	0.0790
The A50 spot market did not Granger-cause the CSI 300 spot market	989.7955	0.0000	-3.3328E-04	0.0348
Panel B: Causality Test for Five-Minute Returns				
The CSI 300 future market did not Granger-cause the CSI 300 spot market	88.4284	0.0000	-2.0334E-02	0.0369
The CSI 300 spot market did not Granger-cause the CSI 300 futures market	1.8333	0.0574	-2.1263E-02	0.0459
The A50 futures market did not Granger-cause the A50 spot market	15.2561	0.0000	-7.1474E-03	0.2690
The A50 spot market did not Granger-cause the A50 futures market	0.6908	0.7180	-7.7389E-03	0.2572
The CSI 300 futures market did not Granger-cause the A50 futures market	7.1818	0.0000	2.6294E-03	0.0746

The A50 futures market did not Granger-cause the CSI 300 futures market	0.8169	0.6005	-3.6643E-03	0.0153
The CSI 300 spot market did not Granger-cause the A50 spot market	4.3790	0.0000	2.8699E-03	0.0522
The A50 spot market did not Granger-cause the CSI 300 spot market	46.8389	0.0000	-3.5265E-03	0.0190

TABLE 7: HASBROUCK INFORMATION SHARES

	CSI 300 Spot	CSI 300 Futures	A50 Spot	A50 Futures
Panel A: Hasbrouck Information Shares for One-Minute Returns				
mean		73.5764%		26.4236%
upper bound		95.1952%		48.0424%
lower bound		51.9576%		4.8048%
mean	30.0657%	69.9343%		
upper bound	57.8157%	97.6843%		
lower bound	2.3157%	42.1843%		
mean			39.3504%	60.6496%
upper bound			77.1596%	98.4587%
lower bound			1.5413%	22.8404%
mean	57.9567%		42.0433%	
upper bound	97.9845%		82.0710%	
lower bound	17.9290%		2.0155%	
Panel B: Hasbrouck Information Shares for Five-Minute Returns				
mean		63.1085%		36.8915%
upper bound		96.8129%		70.5958%
lower bound		29.4042%		3.1871%
mean	46.6270%	53.3730%		
upper bound	89.5518%	96.2979%		
lower bound	3.7021%	10.4482%		
mean			44.3531%	55.6469%
upper bound			88.3184%	99.6121%
lower bound			0.3879%	11.6816%
mean	60.6821%		39.3179%	
upper bound	95.2111%		73.8468%	
lower bound	26.1532%		4.7889%	

TABLE 8: GONZALO-GRANGER INFORMATION SHARES

	CSI 300 Spot	CSI 300 Futures	A50 Spot	A50 Futures
Panel A: Gonzalo and Granger Test for One -Minute Returns				
		76.7079%		23.2921%
	23.9323%	76.0677%		
			23.7676%	76.2324%
	77.3104%		22.6896%	
Panel B: Gonzalo and Granger Test for Five-Minute Returns				
		75.4335%		24.5665%
	38.5172%	61.4828%		
			16.3926%	83.6074%
	69.4183%		30.5817%	

TABLE 9: HASBROUCK INFORMATION SHARES FOR SUBPERIODS

Panel A: Hasbrouck Information Shares (05/09/2011-08/08/2011)

	CSI 300 Spot	CSI 300 Futures	A50 Spot	A50 Futures
mean		35.7111%		64.2889%
upper bound		71.1189%		99.6968%
lower bound		0.3032%		28.8811%
mean	41.3143%	58.6857%		
upper bound	73.5926%	90.9639%		
lower bound	9.0361%	26.4074%		
mean			49.0312%	50.9688%
upper bound			89.1185%	91.0560%
lower bound			8.9440%	10.8815%
mean	30.8376%		69.1624%	
upper bound	60.6535%		98.9783%	
lower bound	1.0217%		39.3465%	

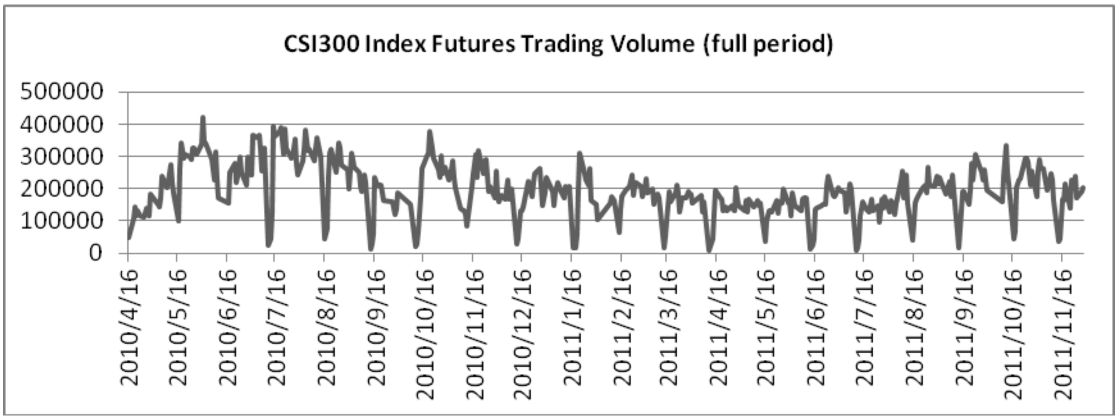
Panel B: Hasbrouck Information Shares (08/09/2011-11/21/2011)

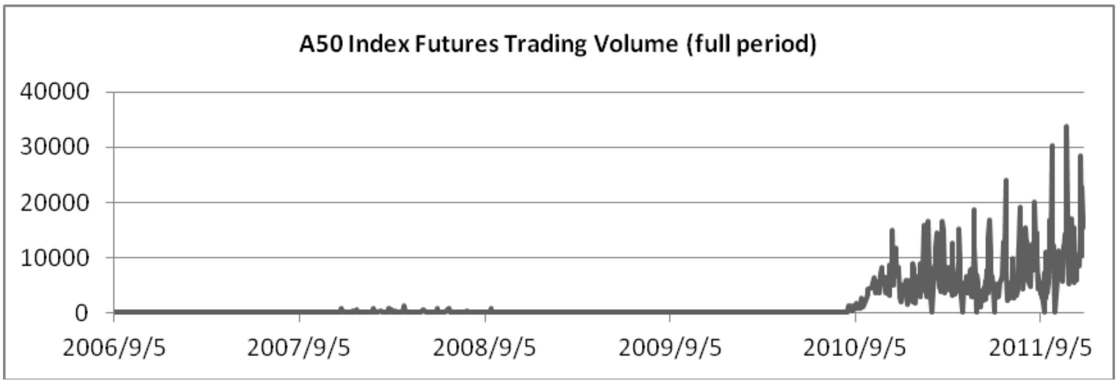
	CSI 300 Spot	CSI 300 Futures	A50 Spot	A50 Futures
mean		74.5129%		25.4871%
upper bound		90.5706%		41.5447%
lower bound		58.4553%		9.4294%
mean	25.9393%	74.0607%		
upper bound	51.0392%	99.1605%		
lower bound	0.8395%	48.9608%		
mean			37.4586%	62.5414%
upper bound			74.2857%	99.3684%
lower bound			0.6316%	25.7143%
mean	60.3198%		39.6802%	
upper bound	99.0742%		78.4346%	
lower bound	21.5654%		0.9258%	

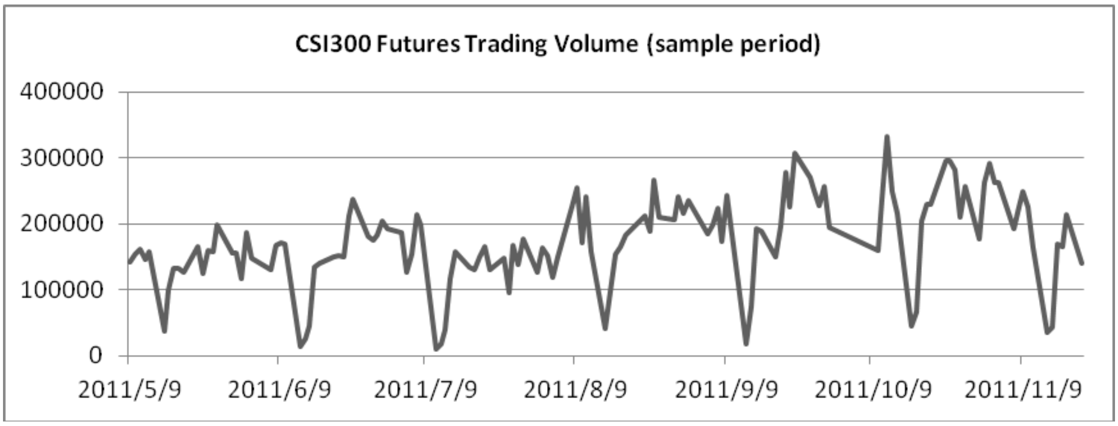
TABLE 10: GONZALO-GRANGER INFORMATION SHARES FOR SUBPERIODS

	CSI 300 Spot	CSI 300 Futures	A50 Spot	A50 Futures
Panel A: Gonzalo and Granger Information Shares (05/09/2011-08/08/2011)				
		9.0904%		90.9096%
	42.4438%	57.5562%		
			51.0910%	48.9090%
	14.8997%		85.1003%	
Panel B: Gonzalo and Granger Information Shares (08/09/2011-11/21/2011)				
		60.0357%		39.9643%
	15.5640%	84.4360%		
			16.1785%	83.8215%
	85.1270%		14.8730%	

Figure 1: TRADING VOLUME: CSI 300 FUTURES VS. A50 FUTURES







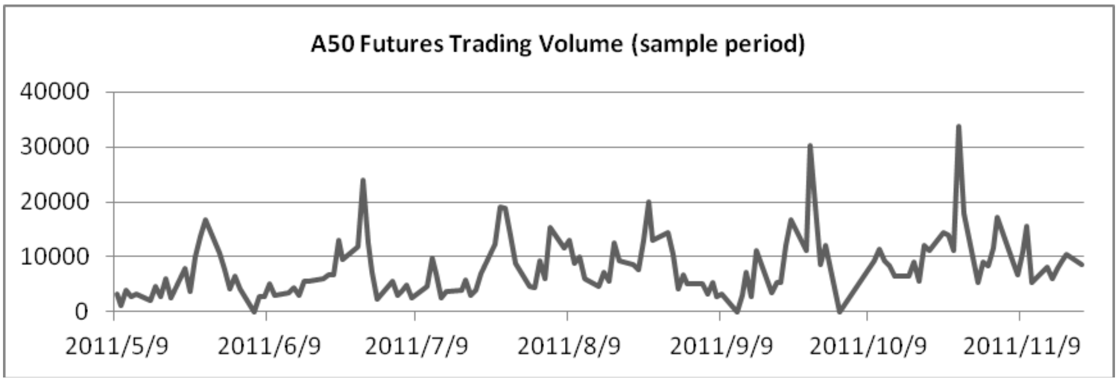
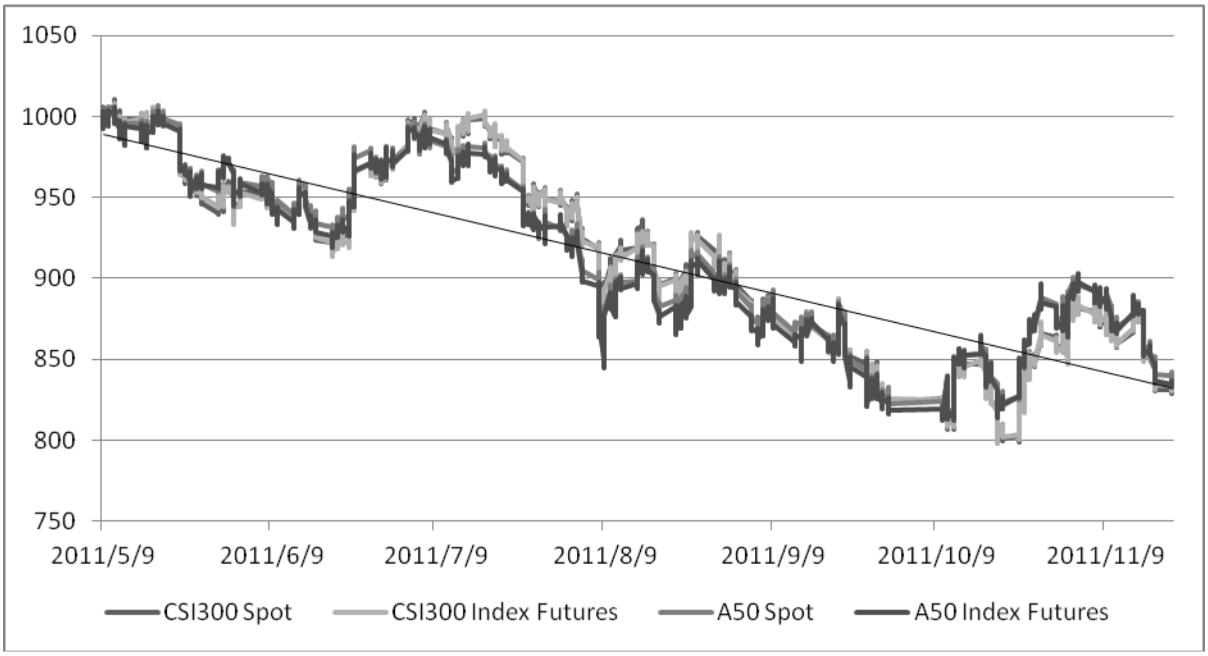


Figure 2: TIME SERIES PLOTS OF FOUR MARKETS (May 2011 to November 2011)



Note: all indices are normalized.